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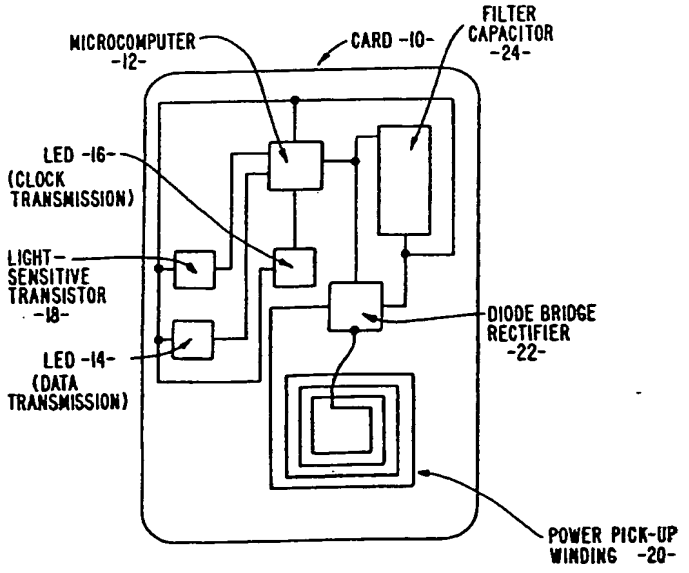
(54) Title: COMPUTERIZED DATA-BEARING CARD AND READER/WRITER THEREFOR

(57) Abstract

A computerized data-bearing card (10) which includes an internal microcomputer (12), and which is constructed so that digitized data may be read from and written into the microcomputer by an indenpendent reader/writer unit. Communication between the card and the reader/writer unit is by means of interactive photoelectric transducers (14, 18) provided in the card and the reader/writer unit. The circuitry within the card is electrically energized by an electromagnetic induction coil (20) from the reader/writer unit, thereby obviating any need for internal batteries, electrical connections to external power supplies, and electric switches.



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# COMPUTERIZED DATA-BEARING CARD AND READER/WRITER THEREFOR

## BACKGROUND OF THE INVENTION

### Field of the Invention

This invention relates to personal identification cards, credit cards, and the like, which have embedded within them circuitry, usually including a microcomputer, for storing and processing data and which are adapted to interact with an external apparatus for accessing and modifying data stored in the card. More particularly, it relates to an improved method and means for transferring data between such cards and apparatus.

### Prior Art

Advances in techniques for microminiaturization of electrical circuitry, and particularly the advent of inexpensive sophisticated microcomputer semiconductor chips, have fanned increasing interest in the development of so called "smart cards." These compact computerized laminated plastic devices have the ability to store and process large amounts of information, and are intended to be used in connection with "reader/writer" terminals adapted to receive, and in some instances alter, delete, or add to, the information contained in the cards' memory. U. S. Patents 4,384,288, 4,582,985, and 4,605,844 describe and discuss typical examples of such cards and terminals.

Such cards have the potential for a myriad of applications. As identification cards they may carry biographical data concerning the owner, and other information, such as his employment history and medical, dental, and benefit-entitlement records. Used with specially designed locks, they may serve as pass keys, or as actuators for powered equipment.

In conjunction with remotely-linked on-site terminals, they lend themselves to use in banking, mercantile, and various other commercial transactions requiring the information contained in the card to be confirmed, modified, and up-dated, each time the card is used.

Heretofore, communication between the reader/writer and the computerized data-bearing card has been achieved by direct electrical contact, electromagnetic coupling, or RF transmission. While by and large these methods are adequate, all of them have certain inherent deficiencies. The principal object of my invention is to avoid these drawbacks by providing an improved method and means for effecting the exchange of data between the reader/writer terminal and the card.

A specific objective of the invention is the provision of an improved interactive computerized data-bearing card which requires no external electrical connections or internal batteries.

Another objective is the provision of computerized data-bearing card and reader/writer therefor which utilize light pulses generated and received by photoelectric transducers, rather than electromagnetic coupling or RF transmission, for the transfer of information to and from the card.

Other objects and advantages will become apparent from the following summary and detailed description of a preferred embodiment of the invention, and its features and operation.

## Summary of the Invention

In its preferred form, the invention comprises a standard wallet-size plastic card containing among its laminated layers solid state circuitry, including a computer or microprocessor, for receiving, processing, and storing intelligence.

A separate reader/writer communicates with the card in digital code by means of pulses of light. Data from the card are transmitted by a light emitting diode (LED) embedded in the card and are received by a photodetector in the reader/writer. Digitized data, including information to be

stored, or used to modify information previously stored in the card's programmable erasable memory, are transmitted by a light emitting diode in the reader/writer to a photosensitive detector incorporated in the card's circuitry.

A clock in the card circuitry provides a reference signal which, when transmitted by its own LED in the card to a second photodetector in the reader/writer, furnishes a control for processing the data signal.

To power the microcomputer, a multi-turn coil of wire is embedded within the card's laminations. A high frequency electromagnetic field provided by a power transformer in the reader/writer induces a voltage in the coil which is rectified, regulated, and used to drive the card circuitry.

## DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic representation showing the manner in which the various electrical and electronic elements and components are embedded in the credit card;

FIG. 2 is a schematic diagram of the circuitry included in the card, in accordance with a particular embodiment of the invention; and

FIG. 3 is a schematic block diagram of a card/writer unit which may be used to access data from the card of FIG. 1, or to introduce new data into the card.

## DETAILED DESCRIPTION OF THE INVENTION

The data-bearing card of the invention is designated 10 in FIG. 1. A microcomputer 12 is embedded in the card. The microcomputer is connected to a light emitting diode LED 14. A second LED 16 is also connected to the microcomputer 12. Output data signals from the microcomputer 12 are transformed into corresponding light signals by the LED 14, and associated clock signals from the microcomputer 12 are transformed into corresponding light clock signals by the LED 16. A light sensitive transistor 18 is connected to the microcomputer 12, and the transistor 18 responds to incoming light signals to introduce corresponding data signals to the microcomputer 12.

A multi-turn power pick-up winding 20 is embedded

in the card, and a high frequency electromagnetic field is used to induce an alternating current voltage across the winding 20. Winding 20 is connected to a diode bridge rectifier 22, and a filter capacitor 24 is connected across the diode bridge rectifier 22, so that appropriate direct current energizing power may be provided for the microcomputer 12.

The various components of FIG. 1 are illustrated in circuit detail in FIG. 2. As shown in FIG. 2, a Zener diode 26 may be connected across the filter capacitor 24 to serve as a voltage regulator.

The microcomputer 12 may be the type marketed by Hitachi and designated No. HD 65901. As shown in FIG. 2, the microcomputer 12 includes a central processor unit (CPU) 12A, a random access memory (RAM) 12B, appropriate input/output circuitry (I/O) 12C, a read-only memory (ROM) 12D, and an electrically alterable programmable read-only memory (EEPROM) 12E. The various components described above are interconnected by a data bus 12F and by an address bus 12G. According to usual practice, the program is stored in ROM 12D, and data may be stored in RAM 12B and/or EEPROM 12E.

The light sensitive transistor 18 is connected to an appropriate pin 1 of the microcomputer 12, to feed input data signals to the microcomputer 12 in response to light data signals directed at the light sensitive transistor 18. LED 14 is connected to a pin 2 of the microcomputer 12, and responds to output data signals from the microcomputer 12 to generate corresponding light data signals. LED 16 is connected to a pin 3 of the microcomputer 12, and responds to clock signals from the microcomputer 12 to produce corresponding light clock signals.

The power supply formed by the power pick-up winding 20 and the diode bridge rectifier 22 is connected to a pin 4 of the microcomputer 12 and to a pin 5. Pin 4 is designated $+V_{CC}$, and pin 5 is ground.

The card reader/writer unit is shown in schematic form in FIG. 3. This unit includes internal processing electronic circuitry represented by block 50. A light sensitive transistor 52 is connected to the processing circuitry to

supply input data signals to the processing circuitry, and a second light sensitive transistor 54 is connected to the processing circuitry to supply clock signals in response to light clock signals incident on transistor 54. Data signals from the circuitry 50 are applied to a LED 56 to be transformed into corresponding light data signals.

The processing circuitry 50 is powered from a DC power supply 58. Power supply 58 is connected to a power oscillator and driver 60 which, in turn, is connected to a winding 62 mounted on a ferrite core 64. Oscillator 60, for example, provides an output signal of a frequency of 10 KHz to the winding 62.

Processing circuitry 50 is connected to an appropriate display, so that information read from the credit card of FIG. 1 may be interpreted. Also, the circuitry 50 may be connected to an appropriate terminal so that data may be processed to be fed into the card of FIG. 1. In addition, the processing circuitry 50 may be coupled to a telephone line through an appropriate MODEM, so that a remote computer may be used to feed data into the card, and to receive data from the card.

The card 10 of FIG. 1, and the reader/writer unit of FIG. 3 are configured so that when the card 10 is inserted into the reader/writer the power pick-up winding 20 is located within the gap of the ferrite core 64, the light sensitive transistor 52 is positioned over LED 14 of the card, the light sensitive transistor 54 is positioned over LED 16 of the card, and the LED 56 is positioned over light sensitive transistor 18 of the card.

In processing the data carried by card 10, insertion of the card 10 into the reader/writer causes the microcomputer 12 within the card 10 to receive power from the power oscillator 16 of the reader/writer unit. Output data from the microcomputer 12 are then sensed by the reader/writer unit by way of light sensitive transistors 52 and 54. Also, new data may be fed into the microcomputer 12 of the card from the processing circuitry 50 by way of LED 56.

The invention provides a simple and inexpensive data-

carrying credit card and reader/writer unit. Since it does not have any external electrical contacts or internal batteries, the card need be no larger than existing conventional credit cards and thus may be carried conveniently. The compact reader/writer unit allows the data on the card to be processed locally, or from a remote terminal.

Although I have described the invention in terms of a preferred embodiment with several specific features, it is not to be construed as limited to that embodiment and those features. They are to be regarded as illustrative rather than restrictive. It is my intention by this specification to include any and all variations of the examples I have chosen for purposes of the disclosure, which do not depart from the spirit and scope of the following claims.

I claim:

CLAIMS

1. A computerized data-bearing card for use in conjunction with a reader/writer unit, comprising:

a thin card-like member insertable into said reader/writer unit and containing microcomputer means;

light-electrical transducer means mounted on the card-like member connected to said mircrcomputer means and responsive to light signals from the reader/writer unit for introducing electric input signals to said microcomputer means; and

electrical-light transducer means mounted on the card-like member and connected to said microcomputer means for converting electric output signals from said microcomputer means into light signals for introduction to the reader/writer unit.

2. The data-bearing card defined in Claim 1, in which said second-named transducer means includes:

a transducer for converting electric data signals from said microcomputer means into corresponding light data signals; and

a transducer for converting electric clock signals from said microcomputer means into corresponding light clock signals.

3. The data-bearing card defined in Claim 1, in which said first-named transducer means comprises at least one light-sensitive transistor.

4. The data-bearing card-like member defined in Claim 1, in which said second-named transducer means comprises at least one light emitting diode.

5. The date-bearing card defined in Claim 1, comprising:

power supply means connected to said microcomputer means, said power supply means including a power transfer winding embedded in the card-like member and responsive to an external magnetic field for generating electric power for said microcomputer means.

6. The data-bearing card defined in Claim 1, in

which said power supply means includes a diode rectifier embedded in said card-like member connected across said winding.

7. A reader/writer unit for use in conjunction with a computerized data-bearing card, comprising:

receiving means in said reader/writer unit adapted to receive said card;

electric signal generating means associated with said reader/writer unit for producing electric output signals;

electrical-light transducer means mounted on said reader/writer unit connected to said signal generating means for converting said electric output signals into light signals for transmission to said card;

electric signal processing means in said reader/writer unit;

display means associated with said reader/writer unit for visually displaying data in response to said signal processing means; and

light-electrical transducer means mounted on said reader/writer unit and responsive to light signals from the card for introducing electric imput signals to said electric signal processing means.

8. The reader/writer unit defined in Claim 7, comprising:

power supply means in said reader/writer unit connected to a source of power, said power supply means including a power transfer winding adapted to produce an external magnetic field for inducing current in a power transfer winding in said card.

9. In combination, a computerized data-bearing card and a reader/writer unit, comprising:

a thin card-like member insertable into said reader/writer unit and containing microcomputer means;

first electrical-light transducer means mounted on the card-like member and connected to said microcomputer means for converting electric output signals from said microcomputer means into light signals for

introduction into the reader/writer unit;

electric signal processing means in said reader/writer unit;

display means associated with said reader/writer unit for visually displaying data in response to said signal processing means;

first light-electrical transducer means mounted on said reader/writer unit and responsive to light signals from said first electrical-light transducer means for introducing electric imput signals to said electric signal processing means;

electric signal generating means in said reader/writer unit for producing electric output signals;

second light-electrical transducer means mounted on said reader/writer unit connected to said signal generating means for converting the electric output signals from said signal generating means into light signals; and

second electrical-light transducer means mounted on said card-like member connected to said microcomputer means and responsive to light signals from said second electrical-light transducer means for introducing electric imput singals to said microcomputer means.

10. The combination defined in Claim 9, in which said first electrical-light transducer means includes:

a transducer for converting electric data signals from said microcomputer means into corresponding light data signals; and

a transducer for converting electric clock signals from said microcomputer means into corresponding light clock signals.

11. The combination defined in Claim 9, in which said second light-electrical transducer means comprises at least one light-sensitive transistor.

12. The combination defined in Claim 9, in which said first electrial-light transducer means comprises at least one light emitting diode.

13. The combination defined in Claim 9, comprising:

first power supply means in said card-like member connected to said microcomputer means and including a first power transfer winding embedded in the card-like member; and

second power supply means in said reader/writer unit connected to a source of power, said second power supply means including a second power transfer winding adapted to produce a magnetic field for generating current in said first power transfer winding and thereby providing electric power to said microcomputer means.

14. The combination defined in Claim 13, in which said first power supply means includes a diode rectifier embedded in said-like member connected across said first winding.

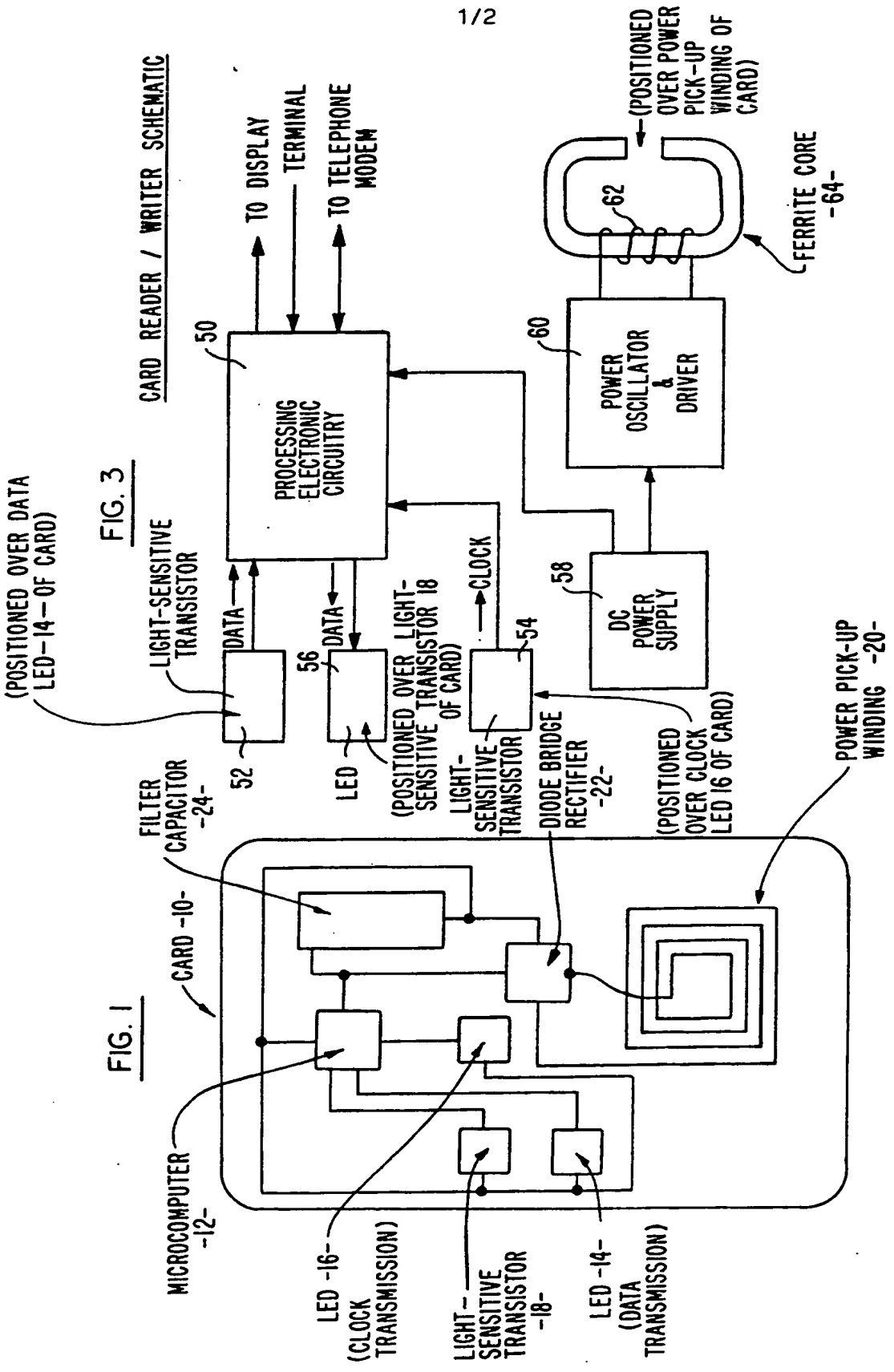
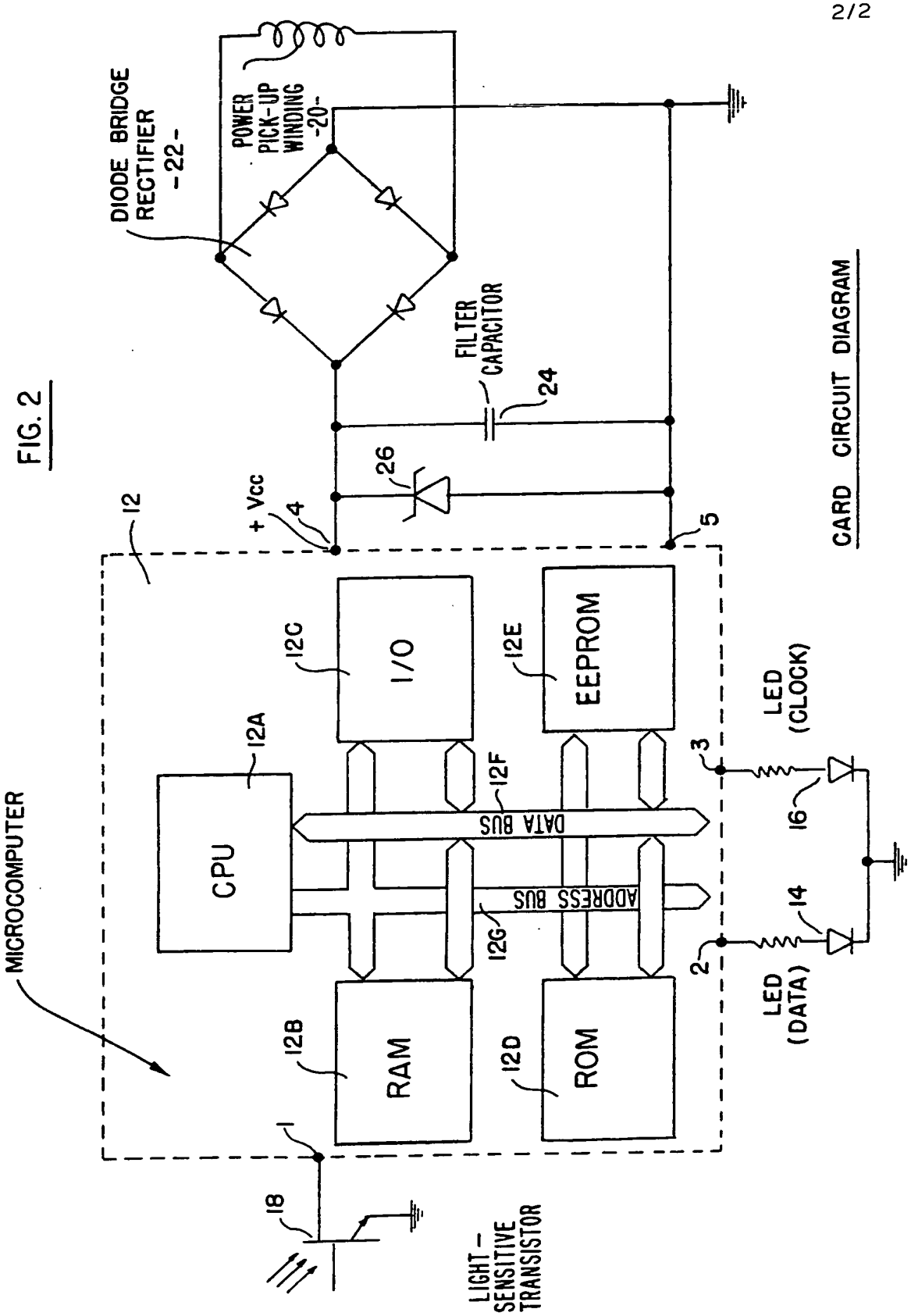

CARD READER / WRITER SCHEMATIC
TO DISPLAY TERMINAL
TO TELEPHONE MODEM
(POSITIONED OVER POWER PICK-UP WINDING OF CARD)
FERRITE CORE -64-
62
60
POWER OSCILLATOR & DRIVER
50
PROCESSING ELECTRONIC CIRCUITRY
58
DC POWER SUPPLY
(POSITIONED OVER DATA LED-14-OF CARD)
LIGHT-SENSITIVE TRANSISTOR
DATA
DATA
CLOCK
56
54
52
LED
(POSITIONED OVER LIGHT-SENSITIVE TRANSISTOR 18 OF CARD)
LIGHT-SENSITIVE TRANSISTOR
DIODE BRIDGE RECTIFIER -22-
(POSITIONED OVER CLOCK LED 16 OF CARD)
POWER PICK-UP WINDING -20-
FILTER CAPACITOR -24-
CARD -10-
MICROCOMPUTER -12-
LED -16- (CLOCK TRANSMISSION)
LIGHT-SENSITIVE TRANSISTOR -18-
LED -14- (DATA TRANSMISSION)

FIG. 3

FIG. 1

FIG. 2


CARD CIRCUIT DIAGRAM
DIODE BRIDGE RECTIFIER -22-
POWER PICK-UP WINDING -20-
FILTER CAPACITOR
24
26
+ Vcc
4
5
12
MICROCOMPUTER
12A
CPU
12B
RAM
12C
I/O
12D
ROM
12E
EEPROM
12F
DATA BUS
12G
ADDRESS BUS
1
2
3
LED (DATA)
LED (CLOCK)
14
16
18
LIGHT-SENSITIVE TRANSISTOR

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/00466

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): G06F 15/30 G06K 5/00

U.S. CL 235/379,380

## II. FIELDS SEARCHED

Minimum Documentation Searched [4]

| Classification System | Classification Symbols |
|---|---|
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

| Category * | Citation of Document, [16] with indication, where appropriate, of the relevant passages [17] | Relevant to Claim No. [18] |
|---|---|---|
| X | US, A, 4,454,414 (BENTON) 12 JUNE 1984 See the entire document. | 1-14 |
| X | US, A, 4,523,297 (UGON et al.) 11 June 1985 See the entire document. | 1-14 |
| X | US, A, 4,529,870 (CHAUM) 16 JULY 1985 See the entire document. | 1-14 |
| X | US, A, 4,538,056 (YOUNG et al.) 27 AUGUST 1985 See the entire document. | 1-14 |

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## IV. CERTIFICATION

| Date of the Actual Completion of the International Search [2] | Date of Mailing of this International Search Report [2] |
|---|---|
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| International Searching Authority [1] | Signature of Authorized Officer [20] |
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